

An exploration of the longitudinal relation between parental feeding practices and child anthropometric adiposity measures from the West Midlands Active Lifestyle and Healthy Eating in Schoolchildren (WAVES) Study

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An exploration of the longitudinal relationship between parental feeding practices and child anthropometric adiposity measures from the WAVES study

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Short running head: Parent feeding, child eating, and weight status

Abbreviations:

BMI	Body Mass Index
CEBQ	Child Eating Behaviours Questionnaire
CFPQ	Comprehensive Feeding Practices Questionnaire
IMD	Index of Multiple Deprivation
WAVES	West Midlands ActiVe lifestyle and healthy Eating in School children study
UK	United Kingdom

1 *Abstract:*

2 **Background:** Some research suggests that parent/carer feeding practices may
3 influence children's weight patterns, but longitudinal evidence is limited and
4 inconsistent.

5 **Objective:** To investigate the relationship between various parent/carer feeding
6 practices when a child is 7-8 years and proxy measurements of child adiposity at 8-9
7 years (weight status, waist-to-height ratio, and body fat percentage).

8 **Design:** Secondary analysis of data from the West Midlands ActiVe lifestyle and
9 healthy Eating in School children (WAVES) study comprising a diverse sample of
10 parents/carers and their children from 54 primary schools in the West Midlands,
11 England (n= 774 parent-child dyads (53% of the WAVES study sample)). Information
12 on feeding practices was collected using subscales from Comprehensive Feeding
13 Practices Questionnaire, completed by the child's main parent/carer (self-defined).
14 Child height, weight, body fat percentage, and waist circumference were measured
15 and converted into three proxy measurements of adiposity (weight status, waist-to-
16 height ratio, and body fat percentage). Associations between these measurements
17 and parent/carer feeding practices were examined using mixed-effects logistic
18 regression models.

19 **Results:** Of the questionnaire respondents, 80% were mothers, 16% were fathers
20 and 4% other carers. Median standardised subscale scores ranged from 1.7
21 (Interquartile Range=1.0; (emotion regulation)) to 4.0 (Interquartile Range =1.5;
22 (monitoring and modelling)) and significantly different subscale scores were present
23 between child weight statuses for emotion regulation, pressure-to-eat, and restriction

24 for weight control. Logistic regression modelling showed that when baseline
25 adiposity measures were included as covariates, all associations between parental
26 feeding practices at age 7-8 years and measures of adiposity at age 8-9 years were
27 attenuated.

28 **Conclusions:** Observed relationships between various parental feeding practices
29 and later are mitigated by inclusion of the baseline adiposity measure. This finding
30 lends support to the theory of reverse causation, whereby the child's size may
31 influence parental choice of specific feeding practices, rather than the child's
32 subsequent weight status being a consequence of these feeding practices.

33 **Introduction:**

34 Excess weight in children is an important public health concern, with adverse
35 physical and psychosocial consequences in childhood, and increased risk of
36 morbidity and mortality in later life (1, 2). Two recent reviews have highlighted that
37 common environmental factors, such as parent feeding practices, have a substantial
38 effect on Body Mass Index (BMI) from childhood through to adolescence (3) and that
39 parental food habits and feeding practices are the most dominant family system
40 determinants of children's eating habits and food choices (4). There is also evidence
41 of 'intergenerational ripples', whereby parents develop their feeding practices based
42 on their own childhood feeding experience (5). Therefore, understanding the effect of
43 parental feeding practices on children's adiposity has been identified as a research
44 priority, as it could inform the development of interventions with potential impact
45 beyond the current generation (6).

46 Parent feeding practices relate to the specific methods and behaviours that parents
47 employ to influence children's behaviour, health, or weight (7, 8) and are distinct
48 from the more generalistic parent feeding style which typifies the levels of
49 demandingness and responsiveness a parent expresses in feeding and eating
50 interactions (9, 10). Examples of parental feeding practices include pressuring
51 children to eat certain foods, using food as a reward, or not allowing the child to eat
52 certain foods. Evidence from a variety of studies suggests that certain parent feeding
53 practices are associated with child weight status. For example, restrictive feeding
54 practices are associated with higher weight status (11-16), whilst pressure to eat is
55 related to lower weight status (11, 15-18). However, these findings are inconsistent
56 and sometimes conflicting (18-22), particularly in relation to other parent feeding

practices (for example, using food as a reward (15, 16, 19, 20)). A number of methodological limitations in previous studies constrain potential interpretation. For example, most were cross-sectional in nature, and the measures of adiposity used have been limited, with few previous studies using multiple measures such as waist-to-height ratio or body fat percentage. Additionally, previous studies rarely consider how child characteristics influence parental feeding practices. Shloim *et al.* (2015) noted in their systematic review of studies ($n = 31$) that, where child characteristics were measured, the parental feeding practices employed were responsive to the child. For example, more restriction was seen in children with greater adiposity or greater perceived food approach tendencies and more pressure to eat in thinner children or those perceived to be undereating (10). However, the direction of the proposed effect is still ambiguous. Therefore, it is important to consider the possibility of reverse causation, whereby parental use of specific feeding practices may be driven by a child's weight status, rather than subsequent child weight status being a consequence of them. Additionally, much of the research focus in this area has been on young children and so little is known about whether a relationship between these factors exists in older children when they begin to exert some level of autonomy over their food decisions.

This study investigates the relationship between parent feeding practices when children are aged 7-8 years, and their adiposity measures at 8-9 years, using a socially and ethnically diverse sample of UK families. Adiposity is assessed through the primary outcome of weight status based on BMI z-score and the secondary outcomes of waist-to-height ratio, and body fat percentage.

81 **Methods:**

82 We conducted a secondary analysis of data collected between 2011 and 2014 at
83 baseline (T0: children aged 5-6 years), first (T1: children aged 7-8 years) and second
84 (T2: children aged 8-9 years) follow-up for the **West Midlands ActiVe** lifestyle and
85 healthy **Eating in School** children (WAVES) study; a cluster-randomised controlled
86 trial evaluating the clinical and cost-effectiveness of an obesity prevention
87 programme in an ethnically diverse population of children from the West Midlands,
88 UK. National Health Service Research Ethics approval for the WAVES study was
89 obtained from the Black Country Research Ethics Committee (NHS REC
90 no.10/H1202/69) and the trial was registered in May 2010 (ISRCTN97000586).

91 The WAVES study cohort was recruited from 54 state-funded primary schools in the
92 West Midlands, UK. Written informed consent was obtained from parents and verbal
93 assent was obtained from each child prior to measurements commencing. Further
94 information can be found in the WAVES study protocol (23).

95 Trained researchers, blind to the WAVES study trial arm allocation, measured the
96 height, weight and waist circumference of each child in school at each time point,
97 using validated instruments (Leicester Height Measure MK II (Harlow Healthcare,
98 UK) and Tanita BC-420MA Class 111 Body Composition Analyser (Tanita, Japan))
99 and standard protocols (23). Child weight status was dichotomised into individuals
100 with overweight (including individuals with obesity) or individuals without overweight
101 using the age and sex specific 85th centile cut-off from the UK 1990 growth reference
102 charts (24). Waist-to-height ratio was calculated by dividing the child's waist
103 circumference (cm) by their height (m) and dichotomised into high or low risk using a
104 threshold of 0.5 (25, 26). Body fat percentage was calculated using bioelectrical

105 impedance (27) and was dichotomised using the age and sex specific threshold for a
106 high body fat percentage for each child provided by Tanita® (28).

107 Data on parent feeding practices were collected through a self-administered
108 questionnaire booklet sent home for completion by the child's main parent or carer
109 (self-defined) at T1. Subscales of the Comprehensive Feeding Practices
110 Questionnaire (CFPQ) were used to assess a wide range of parent feeding practices
111 (29). The CFPQ has been shown to be valid in children up to twelve years old (22,
112 29, 30) and in varied cultural contexts (30-32). To keep respondent burden to a
113 minimum, only the following subscales were included in the WAVES study parent
114 questionnaire: child control; emotion regulation; environment; food as a reward;
115 modelling; monitoring; pressure to eat; and restriction for weight control. Minor
116 wording changes from the original questionnaire were applied to make the tool
117 appropriate for a UK population e.g. replacing 'Soda' with 'Fizzy pop'.

118 Likert scales ranging from one (never) to five (always) scored each item. For ease of
119 interpretation, item scores were summed, and then divided by the number of items in
120 the subscale. Subscale scores were not calculated if there were missing data from
121 more than one (3-5 item scales) or two (6-8 item scales) item(s). Where subscale
122 scores were calculated with missing data, the subscale was standardised using the
123 completed number of items as the denominator. Questionnaire subscale response
124 rates ranged from 89% (modelling) to 92% (emotion regulation). All questionnaire
125 subscales had moderate to good internal consistency with Cronbach Alphas (α)
126 ranging from 0.6 (environment) to 0.9 (monitoring).

127 Parent reported home postcodes, mapped to the English Indices of Multiple
128 Deprivation 2007 (IMD), were used as a measure of socioeconomic status (using the

quintile cut offs for England) (33). Child eating behaviour subscales of ‘food responsiveness’, ‘enjoyment of food’ and ‘emotional over eating’ were collected from the Child Eating Behaviour Questionnaire (CEBQ) embedded within the WAVES parent questionnaire booklet. Scoring of these subscales was conducted in the same manner as the CFPQ. As these three CEBQ subscales all represent eating behaviours that potentially lead to greater food intake, they were combined to create one “food approaching eating behaviour” score. Other relevant information (parent age and ethnicity (using the UK census ethnic group categories (34))) were also collected through the WAVES study parent questionnaire booklet. Where parent ethnicity was missing, child ethnicity from school records was used as a proxy.

Parents and children participating in the WAVES study were included in the present study if a questionnaire booklet was returned at T1 and any child anthropometric adiposity measurement (weight status, waist-to-height ratio or body fat percentage) was available at T2. Statistical analysis was performed using STATA 13 (StataCorp LP, US) and, due to multiple tests being performed, a conservative *a priori* significance level of 1% (two-sided) was utilised. Descriptive statistics to summarise participant characteristics are presented by child weight status. The internal validity of all questionnaire subscales was assessed using Cronbach Alpha.

To account for the clustered nature of the sample, mixed-effects logistic regression models were used to evaluate the relationship between CFPQ subscales and each anthropometric outcome measure. Three models were developed. Model 1 was adjusted only for the WAVES study trial arm allocation (fixed effect) and school attended (random effect) to account for the data being collected after delivery of the WAVES study intervention and the clustered nature of the sample. Model 2 was additionally adjusted for the sex of the child, child food approaching feeding

behaviour score, IMD score (deprivation index), and parent level factors (age and ethnicity). Model 3 was further adjusted for T0 values for the outcome measure (BMI z-score, waist-to-height ratio or body fat percentage) to investigate whether any associations exist independently of baseline values.

To consider the impact of missing data on the relationships investigated, all further adjusted models (Model 3) were repeated on a dataset where missing covariate information was imputed. Generation of imputed datasets was conducted in REALCOM-Impute (35) to account for the clustered nature of the sample, imported into STATA using the `realcomImputeLoad` command, and analysed in STATA 13. Generation of imputed datasets included the following incomplete variables: T2 outcome of interest, T0 outcome measure, child food approaching eating behaviour composite score, parent age, parent ethnicity (White, South Asian, Black African-Caribbean and Mixed/Other ethnicities), deprivation score of household (IMD 2010). Additionally, the following complete variables were included to improve the accuracy of the imputation: sex of the child, WAVES study trial arm, school level free school meal entitlement proportion, and school level ethnic mix (White, South Asian, Black African-Caribbean and Mixed/Other ethnicities). The results of ten imputed datasets were pooled to produce imputation estimates.

Results:

There were between 716-774 parent-child dyads included in these analyses (49-53% of the WAVES study participants, **Figure 1**). Parents of White children were the most likely to respond to the questionnaire (64%) and parents of Black children were least likely to respond (44%). Additionally, there was a graded response rate across the deprivation quintiles, with the highest responses coming from the least deprived

quintile (75%) and the lowest from the most deprived quintile (53%). There was no difference in the response rates according to the age or sex of the child (Supplemental Table 1).

Child and parent characteristics at T2 (aged 8-9 years) are described by child weight status in **Table 1**. Overall, 80% of responders were mothers, 16% fathers, and 4% other relatives (e.g. grandmother, stepfather, or aunt). The mean parent age was 36.7 years (standard deviation (SD) 6.7 years). Additionally, almost a third of children were identified with overweight (30.6%). A slightly higher proportion of boys than girls had overweight and children of a mixed, Black or South Asian ethnicity were more likely to have overweight than White children, which is in line with England averages (36). However, there was only a significant difference in children of a Black ethnicity.

High median scores were seen in the parent feeding practices of monitoring and modelling (median scores 4.0 (Interquartile range (IQR) 1.5)), indicating that parents employed these practices most frequently (**Figure 2**). Significant differences between weight status groups were evident for the parent feeding practices of emotion regulation, pressure to eat, and restriction for weight control, with parents of children with overweight using more restriction and emotion regulation and less pressure to eat.

Association with proxy measures of child adiposity

Similar patterns emerged across all proxy measurements for adiposity (**Figure 3**). In Models 1 (minimal adjustment) and 2 (which accounted for most covariates), a significantly increased risk of overweight, central adiposity, or high body fat percentage were found if parents employed restriction and a significantly decreased

risk if parents employed pressure to eat. However, after the inclusion of a baseline measure for the adiposity outcome being considered (Model 3), the effect sizes were reduced and these associations were no longer significant. Interestingly, a significantly lower risk of adiposity, measured by all three outcomes (risk of overweight, high waist to height ratio, or high body fat percentage), was seen with greater use of food as a reward in Model 2, however in all cases, this association was attenuated in the subsequent model that adjusted for baseline values. Multiple imputation in Model 3 generated results which were similar to the main analyses, whereby no parent feeding practice was significantly associated with any measure of overweight at the 1% level.

Discussion

The aim of this study was to investigate the relationship between parental feeding practices and three proxy measures of child adiposity a year later, in an ethnically diverse sample of UK children. Although there were associations between certain parental feeding practices and measures of child adiposity, inclusion of a baseline adiposity measure attenuated the observed relationships. This finding has two potential explanations. First, it may lend support to the theory of reverse causation, whereby it is the child's level of adiposity that may lead to parental utilisation of specific feeding practices, rather than being a consequence of them. However, it may also be suggestive of a reduced impact of parental feeding practices on adiposity in older children.

Before adjusting for baseline values we found significant associations between 'restriction for weight control' and 'pressure-to-eat' with child levels of adiposity, which was consistent with previous research findings (13, 16). However, once we

included baseline adiposity in the models, the effect sizes approached null and the associations were no longer statistically significant. This suggests that the use of these feeding practices may be in response to initial child weight status (37, 38). Thus, parents of higher weight children may be more likely to implement restrictive feeding practices whilst parents of lower weight children may pressure their child to eat. This complements a finding by Gregory et al. (2010; n = 156) which suggested that mothers' feeding practices may influence children's eating behaviours, but not their weight status after one year in children aged 2-4 years (39). Both the present study and the study by Gregory et al. (2010) had relatively short follow-up periods which limit the ability to capture the impact on weight status of altered eating behaviours as a result of a parent feeding practice. However, Webber et al. (2010; n= 113) also found no significant longitudinal associations between maternal feeding practices and change in child adiposity three years later, in children aged 7-9 years (40).

Our findings contradict a body of evidence that suggested restriction is associated with increased child weight, both cross-sectionally (11, 14, 41, 42) and longitudinally (40, 43). Mechanisms to explain why restriction may be a counterproductive feeding practice relate to food becoming more desirable and so consumed in excess when outside of the parent's control (44). Given the larger sample size and longitudinal nature of our study, our findings challenge these previous theories; however, it is important to note that the confidence intervals were wide in Model 3, and in some cases, only just crossed the point of no significance. Additionally, it has been hypothesised that the influence of parental feeding practices may be stronger at younger ages (45-47), and therefore the pre-adolescent age range included in the present study may indicate the point at which children begin to strive for greater

autonomy around their feeding and, as such, parental feeding practices begin to have a lesser impact on subsequent child weight. Hence, the null findings in both the present study and that of Webber et al. (2010) may be due to the age group studied (40). Such information is important for future childhood obesity prevention strategies and so further investigations of longitudinal relationships at various ages are needed.

Several strengths and limitations are noteworthy within this study. First, whilst the diverse nature of the West Midlands population, the purposeful oversampling of schools with higher proportions of South Asian and Black children in the WAVES study, and the availability of questionnaire responses from the main carer (including mothers, fathers, and other guardians/carers), may have maximised the external validity of the study findings, it also adds an element of heterogeneity to the sample which may reduce the power to detect true effect estimates in certain sub-groups (48). However, the models were developed to control for various demographic factors to counteract this variability. Second, whilst all outcome data were objectively measured by trained researchers, parent data were all self-reported, and child eating behaviour was based on parent perception and therefore may be subject to some social desirability bias. However, validation studies on both the CEBQ and CFPQ have reported that the responses correlate well with observed practices and behaviours and so these questionnaires allow a relatively quick and cost-effective method of collecting this data on a large scale (29, 49). Third, some variables were missing a substantial amount of data. To assess the impact of this missing covariate data, multiple imputation sensitivity analyses were conducted and the results were found to be very similar to the results of the main analyses, increasing the confidence in our conclusions. Additionally, despite the researchers employing

275 numerous techniques to encourage questionnaire completion the parental response
276 rate was relatively low which may bias the results presented.

277 This study has allowed further exploration of a wide range of parent feeding
278 practices and their relationships with a number of proxy measurements for child
279 adiposity. It has extended the current evidence by allowing adjustment for the child's
280 previous level of adiposity and current eating behaviour. The pathway to which
281 parent feeding practices are often hypothesised to impact child adiposity is through
282 changes in dietary behaviour, for example the use of emotion regulation
283 inadvertently encouraging intake of energy dense, nutrient poor foods in times of
284 distress, leading to excess energy intake and overweight over time. Therefore, it
285 would be useful for future research to quantify the impact these feeding practices
286 may have on dietary intake. Additionally, qualitative studies, investigating why
287 parents adopt such feeding practices, would contribute to understanding the complex
288 relationship between feeding practices and weight status. Finally, the findings of this
289 study challenge the notion that parent feeding practices are associated with
290 adiposity, particularly in older children. However, further evidence is needed to
291 evaluate whether this is a result of reverse causation or an artefact of the changing
292 feeding relationship between parents and their growing children.

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317 **Conflict of Interest**

318 The authors declare no conflict of interest.

319 Author contributions

320 PA, MJP and ERL, alongside the WAVES study trial investigators, designed the
 321 original WAVES study research; KLH developed the research plan for this paper,
 322 conducted the data collection and wrote the paper, with significant input from PA,
 323 MJP, and ERL. All authors read and approved the final manuscript.

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Tables

Table 1: Participant characteristics, by weight status at T2 (aged 8-9 years)

	Not overweight/ Obese ¹ (n=626)	Overweight/ Obese ¹ (n=207)	p-value
Child Age (years) N=833, mean (SD) ²	7.7 (0.3)	7.7 (0.3)	0.389
Sex of the child (N=833, n (%)) ³			
Males	310 (73.5)	112 (26.5)	(reference)
Females	316 (76.9)	95 (23.1)	0.237
Child Ethnicity (N=833, n (%)) ³			
White	320 (77.3)	94 (22.7)	(reference)
South Asian	190 (74.8)	64 (25.2)	0.492
Black	30 (60.0)	20 (40.0)	0.020
Other/Mixed	86 (74.8)	29 (25.2)	0.604
Average physical activity energy expenditure (kJ/kg/day; mean (SD); N=802) ²	92.7 (25.5)	87.5 (22.4)	0.024
IMD quintiles (N=824, n (%)) ³			
Quintile 1 (more deprived)	298 (72.9)	111 (27.1)	(reference)
Quintile 2	120 (77.4)	35 (22.6)	0.272
Quintile 3	72 (78.3)	20 (21.7)	0.230
Quintile 4	66 (75.9)	21 (24.1)	0.550
Quintile 5 (less deprived)	62 (76.5)	19 (23.5)	0.748
Main carer relationship to child (N=828, n (%)) ³			
Mother	509 (76.7)	155 (23.3)	(reference)
Father	91 (69.5)	40 (30.5)	0.088
Other	22 (66.7)	11 (33.3)	0.200
Main carer age ((years) N=781, mean (SD)) ²	36.7 (6.6)	37.0 (6.9)	0.512

¹ Based on the UK 1990 growth reference data (UK90);

² p-values generated using mixed effect linear regression models, fitting weight status as a continuous variable, , controlling for WAVES study trial arm allocation as a fixed effect, and school attended as a random effect

³ p-values generated using multinomial logistic regression models, fitting weight status as a continuous variable, controlling for WAVES study trial arm allocation as a fixed effect, and using robust standard errors to account for clustering

Figures

Figure 1: Flow diagram of participants from the over-arching WAVES study into the present study

Figure 2: Median scores for each parent feeding practice by child weight status at T2 (aged 8-9 years) and p-for-trends generated using mixed-effects linear regressions. Children without overweight/obesity, n=626, children identified with overweight and obesity, n= 207.

Figure 3: Mixed effects logistic regression generated odds ratios (and 99% confidence intervals) to show the association between parent feeding styles and three proxy measures for child adiposity. Maximum number included in models, n=716, minimum number included in models, n=549.